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FOR RELEASE: IMMEDIATE
August 11, 1966

RELEASE NO: 66-211

PROJECT: PIONEER B

(To be launched no earlier than Aug. 17)

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NEWS NASA

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NASA SCHEDULES SECOND IN NEW PIONEER SERIES

The United States will launch the second in the new series of Pioneer spacecraft into orbit around the Sun from Cape Kennedy, Fla., by a Delta rocket no earlier than August 17, 1966.

Called Pioneer B, it will seek to produce as much new knowledge as Pioneer VI, which was launched last December. If successfully launched, Pioneer B will be renamed Pioneer VII.

Pioneer B will fly an "out" mission, moving in 28 weeks to a position about 12 million miles outside the Earth's orbit, 105 million miles from the Sun, and 34 million miles behind the Earth on a parallel orbit.

The spacecraft is expected to pass close to the Sun-Earth line about 3.5 million miles from Earth, where it may detect the Earth's magnetosphere tail.

Observations of atomic and sub-atomic particles and magnetic fields will be coordinated with other National Aeronautics and Space Administration spacecraft: Pioneer VI, Mariner IV, Explorer XXXIII, and three Orbiting Geophysical Observatories.

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Together, these spacecraft can gather data continuously from events on a strip of the solar surface extending nearly half way around the Sun.

Pioneer B, like Pioneer VI, will be able to "see" better than previous interplanetary spacecraft.

The new 140-pound, drum-shaped Pioneers are unique in that they are "spinners," i.e., continuously scanning a full circle in the plane of the Earth's orbit. They have a data rate 10 times higher than previous interplanetary spacecraft for major parts of their missions.

To date, Pioneer VI has returned 400 million instrument readings. With its seeing ability, Pioneer VI has made a number of discoveries. These include:

. The non-straight-line flow of the solar wind;

. First measurement of average numbers of electrons in interplanetary space (five to ten per cubic centimeter);

. Presence of singly-charged helium ions;

. Many well-defined streams of solar cosmic rays channeled by intertwined magnetic field lines.

Scientists put together these results in the first detailed description of the tenuous solar atmosphere (the region around the Sun containing the solar wind and at least the near planets).

This "model" will help predict the arrival of dangerous high energy solar particles at specific points in space, and thereby could play an important role in insuring protection of Apollo astronauts.

The model can be described as follows:

. The solar wind, the supersonic flow of ionized gas moving constantly outward from the surface of the Sun, establishes the interplanetary magnetic field by drawing out magnetic fields near the Sun. It alters these fields, and its own direction, through collision of numerous solar wind "beams" (masses of gas moving away from the Sun on separate paths).

. The solar magnetic field, which appears to be "snarled" near the Sun, becomes even more bent in the drawing-out process. The result is that the field lines of force, rooted in the Sun and stretched through interplanetary space, are twisted about each other with kinks as tight as 90 degrees or more -- like many strands of spaghetti in boiling water.

. When an explosion occurs on the Sun, generating quantities of high-energy particles (mostly hydrogen and helium nuclei), the particles travel down the twisted magnetic field lines, often at several hundred million miles per hour. These become well-defined "streams" of particles, also called solar cosmic rays.

. This flow, in twisted, clearly-separated streams, often lasts for hours. The Sun appears to "store" high-energy particles near its surface and release them over relatively long periods.

As solar storm activity rises toward its expected 11-year peak, Pioneer B will be expected to add to this picture; to help explain mechanisms of the solar corona; and by measuring particles from the Sun, to learn about events on the Sun itself.

Soon after launch, Pioneer B will begin to fall behind the Earth. Pioneer VI, now being tracked by NASA's long-range antenna, will continue to move ahead of the Earth.

By mid-October 1966, the growth and death of solar events could be observed by spacecraft in the following order as the Sun turns past them on its roughly 26-day rotation:

. Flares will be seen first by Pioneer B, two degrees and 3.2 million miles behind the Earth in solar orbit;

. Then by OGO III and Explorer XXXIII at the Earth; then by Pioneer VI, 54 degrees and 87.6 million miles ahead of the Earth;

. And last by Mariner IV, 146 degrees and 172 million miles ahead of the Earth.

In addition, Pioneer B will pass close to a line through Sun and Earth where it may detect a solar wind at the greatest range to date.

The cavity in the solar wind created by the Earth's magnetic field is believed to be teardrop-shaped, pointing away from the Sun. The tail or wake of the teardrop has been reported (by Luna 10) as far out as the orbit of the Moon, about 240,000 miles.

Mariner IV did not detect the wake at 12 million miles out, but it may have been "blown aside" by the solar wind.

Pioneer B will be launched ahead of the Earth, but the Earth catches it in 38.5 days, passing between the Sun and the spacecraft. At this point, about 3.5 million miles beyond the Earth's orbit, Pioneer B will look for the magnetic tail.

Locating the tail and measuring its thickness could answer an important question regarding the shape of the magnetosphere, and how the interplanetary and Earth's magnetic fields are related.

By studying the tail, Pioneer experiments may help identify the source of charged particles in the Van Allen belts inside the magnetosphere.

The Pioneer program is directed by NASA's Office of Space Science and Applications. Project management is by NASA's Ames Research Center, Mountain View, Cal. The Delta launch vehicle is managed by Goddard Space Flight Center, Greenbelt, Md., and is launched by Kennedy Space Center, Cape Kennedy, Fla.

Communications and tracking will be NASA's Deep Space Network, operated by the Jet Propulsion Laboratory, Pasadena, Cal.

The Pioneer spacecraft are built by TRW Systems Group, Redondo Beach, Cal. The Delta rocket is built by Douglas Aircraft Co., Santa Monica, Cal.

The six scientific experiments were provided by four universities and the Ames and Goddard centers.

Pioneer B is virtually identical to Pioneer VI. The Delta launch rocket will fly a different third stage (FW-4D) which will reduce launch forces on the spacecraft from 27 g to about 23 g.

The magnetic field sensor has been altered slightly for a closer study of very weak fields, and a change of view angle has been made in one of the cosmic ray instruments.

The design life of the mission is six months, but if the spacecraft continues to function well, Pioneer B could return data to DSN antennas as far as 130 million miles from Earth up to two years after launch.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

PIONEER B SPACECRAFT

Overall Configuration

The Pioneers are designed as rugged, high-performance spacecraft, able to return large amounts of data on flights of many months at distances over many millions of miles.

All spacecraft systems have been chosen for simplicity and reliability. Maneuvers, for example, are handled by just one cold-gas jet.

After Pioneer B, three more approved spacecraft remain in the program.

The Pioneers have the highest ratio of scientific instruments to total spacecraft weight of any solar orbiting interplanetary spacecraft to date. Pioneer B weighs 140 pounds and carries 35 pounds of scientific experiments.

By weight the spacecraft consists of 25 per cent experiments, 25 per cent communications, 20 per cent electric power system, 24 per cent structure, cabling, and thermal control system, and six per cent attitude control and propulsion.

The new Pioneers are magnetically the cleanest spacecraft ever built, to allow their magnetometers to sense the interplanetary fields free of interference. The spacecraft field is less than 1/100,000 of the Earth's field.

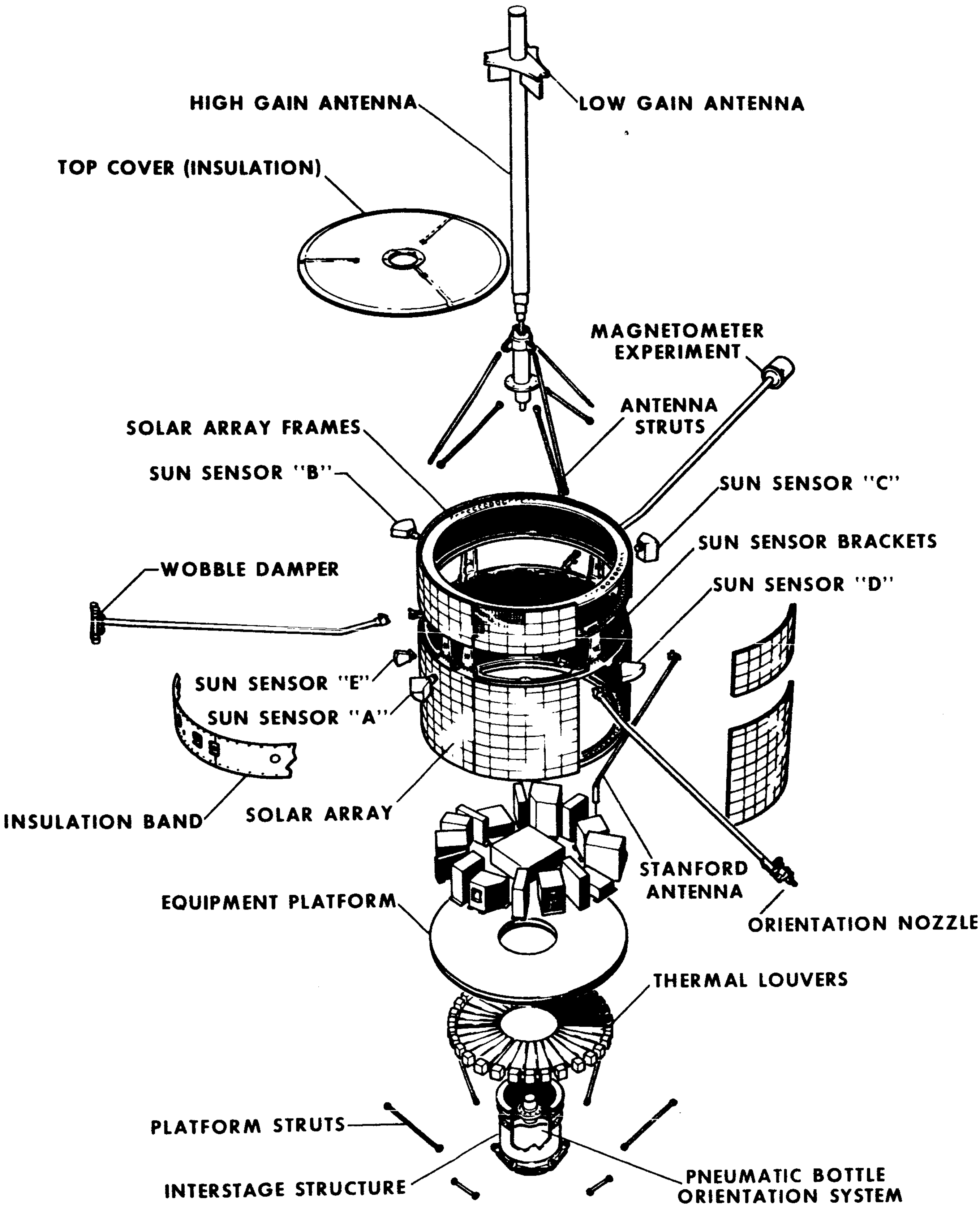
Attitude is extremely stable. For example, after six months in space, Pioneer VI drifted less than 0.2 degree from its attitude after injection into solar orbit.

The spacecraft fits in a drum-shaped container, 35 inches high and 37 inches in diameter.

Its sides are covered with 10,368 solar cells divided by a narrow circular band containing apertures for four experiments and four orientation Sun sensors. A fifth Sun sensor provides the experiments with a continuous directional reference to the Sun's position.

Projecting from the center of one end of the cylinder is a four-foot four-inch rod, the upper quarter of which contains two low-gain antennas, the lower three quarters a high-gain antenna. Extending downward from the other end is another rod-shaped antenna to receive signals for the radio propagation experiments.

PIONEER B SPACECRAFT COMPONENTS



At 120-degree intervals around the sides of the spacecraft are three five-foot four-inch booms. These are folded against the antenna during launch and deployed horizontally in flight by the spin of the spacecraft. One boom carries a gas jet at its end to change spacecraft attitude. A second is tipped by a "wobble damper" to eliminate wobbling rotation. A third boom carries a magnetometer at its tip.

Within the spacecraft a circular platform carries most of the electronics equipment and experiments. Below this platform are narrow pie-shaped, heat-control louvers, and a pressure cylinder containing gas for the orientation system.

The spacecraft structure, made principally of aluminum, is lightweight and its cylindrical shape is inherently strong. There are more than 56,000 parts in Pioneer including its scientific instruments.

Communications System

The 35-pound Pioneer communications, timing, and data handling system has performed well aboard Pioneer VI. It has returned 400 million readings to Earth of 3,300 scientific measurements and 100 engineering measurements. Pioneer VI has received 3,500 commands from the ground.

The same system will be carried by Pioneer B. It is designed to work as follows. It will maintain two-way radio communication with the Deep Space Network (DSN) at about 2300 megacycles on S-band.

Commands go to Pioneer from the DSN antennas in the form of binary code. These commands are received either by a low-gain or high-gain antenna and are routed to one of two redundant radio receivers. They then go to one of two command decoders. Once decoded, each command is routed by the command distribution unit either to a spacecraft system or an experiment, where it is carried out. The spacecraft has a capability to receive 57 separate commands.

To send information back to Earth, the spacecraft driver puts coded data on the basic S-band carrier and routes it to one of the two spacecraft traveling wave tubes, which amplifies the signal to about eight watts. From here the signal goes to the high-gain antenna which transmits it to the big-dish antennas of the DSN.

The Pioneers have the greatest data return capacity of any interplanetary spacecraft because they match the most efficient rate of data return corresponding to distance from the Earth. They return data at five rates, 512, 256, 64, 16 and eight bits per second.

Data are sent in four basic forms: (1) measurements from scientific experiments only, (2) high resolution measurements from the Radio Propagation Detector only, (3) engineering measurements of spacecraft performance only, and (4) limited samplings of engineering data superimposed on science data.

All data are sent in binary code, forming six-bit "words." Words are arrangements of 1's and 0's. For example, the binary word "110010" is the number 50. Scientific and engineering data are handled in 32- and 64-word frames. Periodic code words identify the part of the frame being sent.

The spacecraft data storage unit can receive up to 19 hours of selected information from experiments and store it for later transmission. It is a compact, solid-state memory core with no moving parts. Its 15,232 bits of information storage provide 2,176 data words in 68 frames.

The data telemetry unit turns spacecraft data into binary code for transmission to Earth. It receives information from the data storage unit or directly from experiments and equipment.

Attitude Control

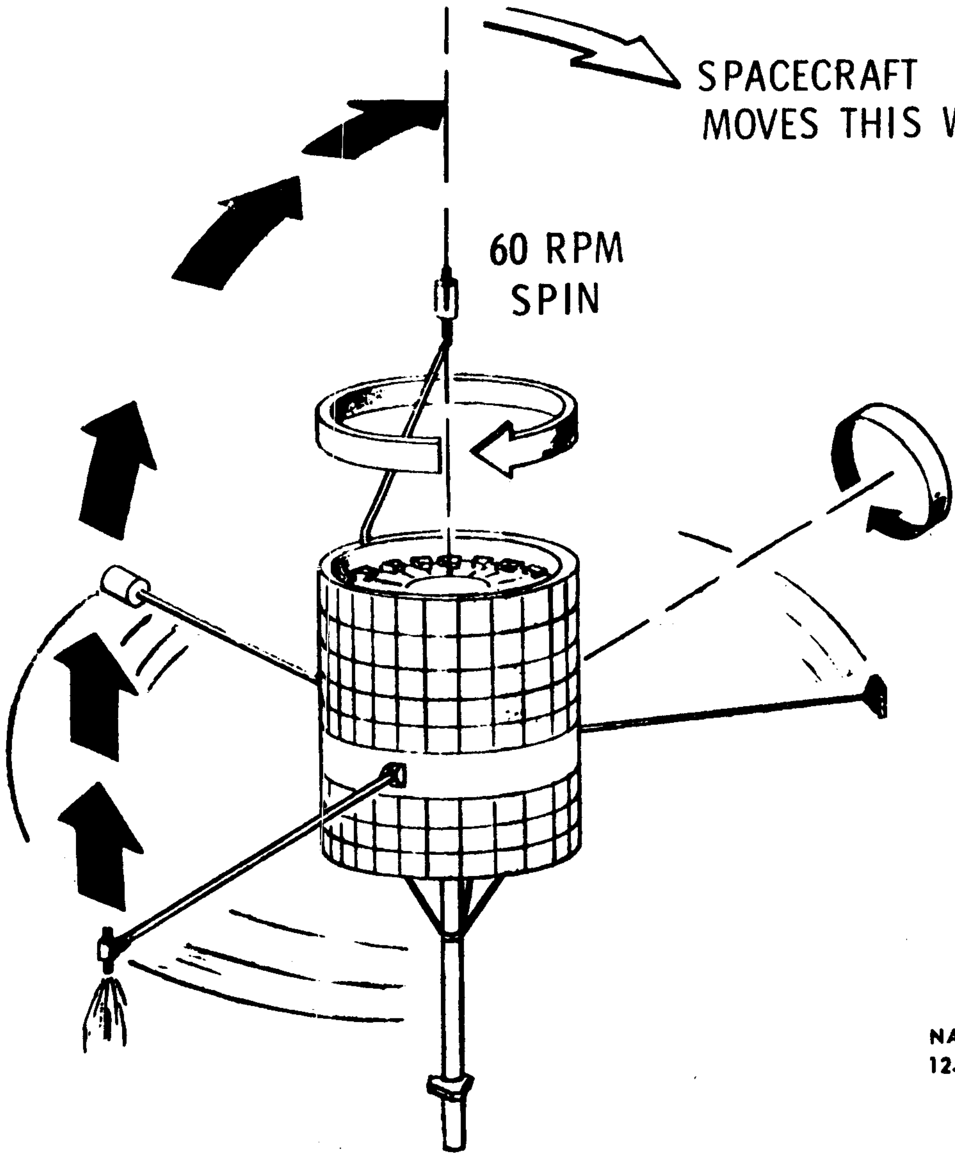
Throughout its mission, Pioneer B will use the gyroscopic effect of its 60-rpm rotation to maintain a precisely stable attitude.

Initial changes in attitude are achieved by turning the spacecraft about an axis through bursts from the nitrogen gas jet at the end of one boom. Force from the gas jet must be applied perpendicular to the desired direction of motion because the spinning craft precesses like a gyroscope.

Each thrust is applied for only ¼-second at just one point on the circle of spacecraft rotation. Thrusts are timed by Sun sensors which see the Sun once each spacecraft revolution and each thrust turns the spacecraft only 3/10-degree.

The many thrusts required at just one point produce wobbling rotation, so the wobble is eliminated by a damper at the end of one boom. Two small balls float in fluid inside a cylinder. The friction of the balls moving through the fluid changes the kinetic energy of the wobble movement into heat which is dissapated. All three spacecraft booms are flexible to help counteract wobble.

PIONEER ORIENTATION MANEUVERING



NASA SL56-16298
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To operate properly, Pioneer B must have its spin axis perpendicular to both Sun-spacecraft line and Earth-spacecraft line, so that solar cells are efficiently illuminated and the narrow beam of the high-gain antenna strikes the Earth.

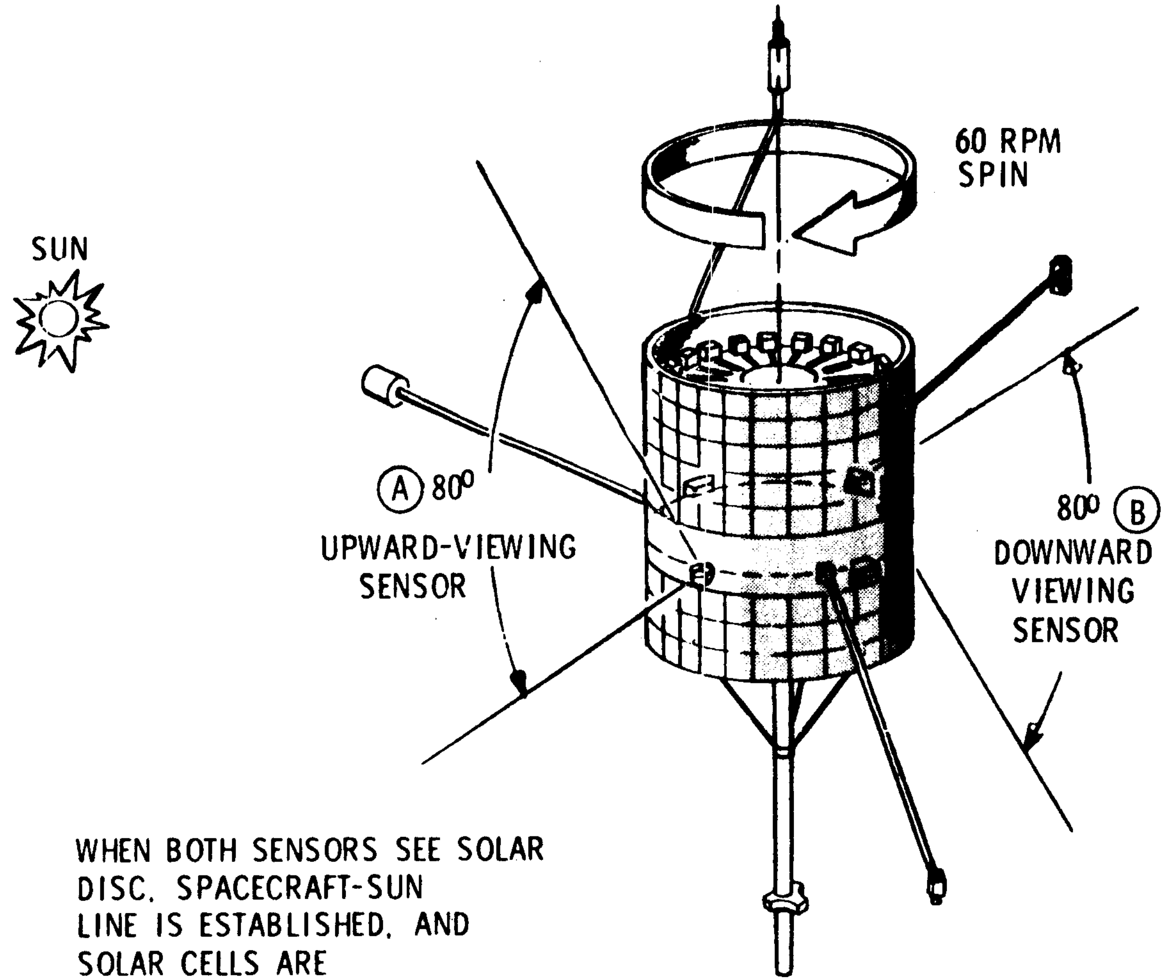
The Sun-orientation maneuver is intended to take place automatically shortly after Pioneer achieves orbit. Earth orientation is planned two days later to focus the high-gain antenna at Earth. This maneuver is essential for Pioneer to be heard by ground stations beyond 10 million miles.

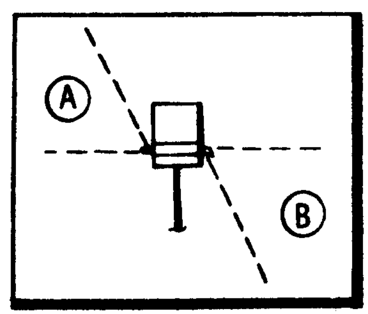
Reference points and timing for placing the spacecraft in this position are provided by four Sun sensors. To orient itself perpendicular to the Sun, Pioneer B uses two sensors. One can see the Sun for 80 degrees above the plane of spacecraft rotation, another for 80 degrees below this plane. When one of these two sensors sees the Sun, logic circuits turn the spacecraft so that the other sensor will also see the Sun.

Turning stops when both sensors see the Sun, hence, spin axis is nominal to the spacecraft-Sun line.

To position the spacecraft perpendicular to the plane of the Earth's orbit so that its narrow-beam radio signal strikes the Earth, ground commands must rotate it around the spacecraft-Sun line.

PIONEER SUN ACQUISITION





WHEN BOTH SENSORS SEE SOLAR DISC, SPACECRAFT-SUN LINE IS ESTABLISHED, AND SOLAR CELLS ARE PERPENDICULAR TO SUN'S RAYS.

NASA SL65-16230
12-3-65

Controllers will first make a short trial rotation around the Sun line and calculate proper direction of rotation from resulting changes in the pattern of the incoming radio signal.

The spacecraft is rotated until it acquires the Earth, then it can be oriented precisely by halting rotation at the point where peak power is received from the high-gain antenna.

The remaining two Sun sensors provide timing for gas jet thrusts to make the Earth orientation maneuver.

Power System

Pioneer B's 10,368 silicon crystal, n-on-p solar cells can provide about 80 watts of power at Earth's distance from the Sun. While slightly less solar energy will reach the spacecraft as it moves away from the Sun, its 60-watt maximum needs will be amply met.

About 30 watts are needed for communications, 10 watts for experiments, and 15 watts for other equipment. Required voltages for individual systems, ranging from three to 12,000 volts are provided by nine voltage converters, and power for all equipment and experiments is supplied from a 28-volt main bus.

Auxiliary power is provided by a rechargeable silver-zinc battery with a life of about one hour without recharging, during operation of the low-power radio. The battery is used primarily during launch before solar cells begin to provide power.

Temperature Control

Temperature aboard Pioneer is controlled by managing the internal heat produced by equipment and by heat-reflective coatings on the surface of the spacecraft to ward off heat radiation from the Sun.

Twenty louvers under the spacecraft equipment platform, actuated by bi-metallic springs, open and close automatically to release enough heat from the spacecraft interior to maintain proper temperatures at specific locations.

Magnetic Field

The magnetic field of the Pioneers is one-half gamma at 80 inches from the center of the spacecraft, making the spacecraft magnetically the cleanest ever built. The Earth's surface measures 50,000 gamma and up to 70,000 gamma at the poles.

Engineers achieved this low magnetism by using non-magnetic materials throughout, particularly plastics, non-ferrous metals, and certain types of wire as well as new fabrication and inspection techniques, and design innovations for low magnetism.

SCIENTIFIC INVESTIGATIONS

Interplanetary space is often regarded as a huge void, and, in fact, it is an extremely tenuous medium with pressures or densities hundredths of thousandths less than have been obtained in the best laboratories on Earth. Nevertheless, space between the planets constitutes a medium through which solar and galactic events propogate and greatly influence our terrestrial environment.

Study of these events also provides data on the basic interactions of high energy charged particles and magnetic fields with direct significance in such fields as nuclear energy production.

These solar disturbances may be larger than the space bounded by the Earth's orbit, and they vary over an 11-year solar cycle.

Known phenomena in interplanetary space generally divide into these categories:

Particles -- Electrons and hydrogen and helium nuclei carrying an electric charge which make up the "solar wind"; cosmic rays which are extremely fast moving or energetic charged nuclear particles of many elements; and cosmic dust and meteoroids.

Radiation -- the entire electromagnetic spectrum such as light, radio and X-rays.

Fields -- magnetic, electric and gravitational.

The six Pioneer experiments are in these areas of study:

- magnetic field (Single Axis Magnetometer);

- the solar wind (Plasma Cup Detector, Quadrispherical Plasma Analyzer, and Radio Propagation Detector);
- cosmic rays (Cosmic Ray Anisotropy Detector and Cosmic Ray Telescope).

Magnetic Field Investigation

The character of the Sun's magnetic field is known only in part. It may be somewhat like the Earth's field, generally a distorted doughnut shape with lines of force issuing from one pole, curving through space, and reentering at the other pole.

But this gross picture is complicated by several factors. The solar wind forms a spiral magnetic field structure as it moves out from the rotating Sun. The Sun's magnetic field may reverse its polarity every solar cycle.

At times there appear to be relatively small, intensely magnetic regions on the Sun with thousands of times the average strength of the solar magnetic field. And huge tongues of ionized gas (solar storms or flares) burst forth from the Sun, to the Earth and beyond.

Single Axis Magnetometer - Goddard Space Flight Center

This experiment charts the Sun's magnetic field from many locations in the plane of the Earth's orbit (the ecliptic).

The experiment sensor is mounted on a boom five feet from the spacecraft to minimize interference from Pioneer's tiny magnetic field.

The experiment uses a single fluxgate sensor, a device which employs a magnetic core and electronic circuitry to measure the magnetic field along the axis of the sensor.

The sensor is oriented about 55 degrees to the spin axis of Pioneer and takes three readings for each rotation of the spacecraft. Because the axes at the time of these three measurements are perpendicular to each other, they enable one to compute the strength and direction of the magnetic field.

The magnetometer can sense magnetic field strengths from plus 32 gamma to minus 32 gamma (at its surface, the Earth's magnetic field is about 50,000 gamma). It has a sensitivity of $\frac{1}{4}$ gamma or 1/200,000 of the Earth's field.

The experiment weighs 5.3 pounds and uses 0.9 watts of power.

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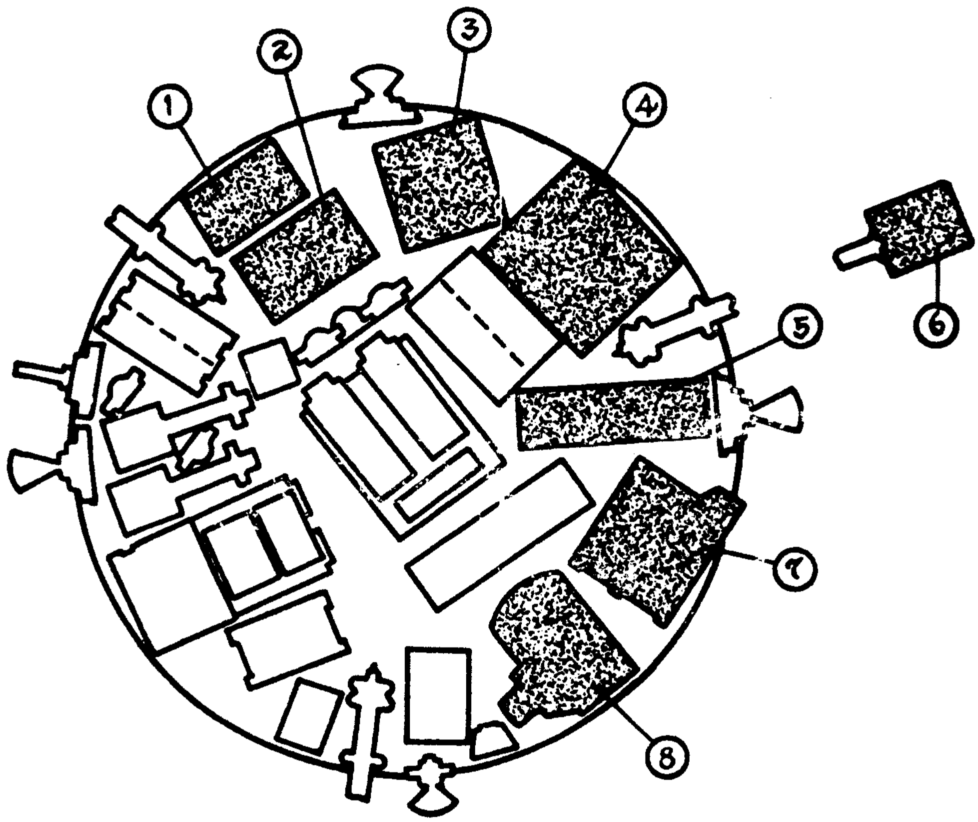
PIONEER B EXPERIMENT ARRANGEMENT (CROSS SECTION)



1. Plasma Cup Detector (sensor) - Massachusetts Institute of Technology

2. Plasma Cup Detector (electronics)

3. Radio Propagation Detector - Stanford University

4. Cosmic Ray Telescope - University of Chicago

5. Single Axis Magnetometer (electronics) - Goddard Space Flight Center

6. Single Axis Magnetometer (sensor at end of five-foot long boom)

7. Quadraspherical Plasma Analyzer - Ames Research Center

8. Cosmic Ray Anisotropy Detector - Graduate Research Center of the Southwest

Solar Wind Studies

An ionized or electrically charged gas boils off from the Sun at speeds averaging about one million mph. This thin moving gas is known as the solar plasma or solar wind and is believed to be made up of electrons and hydrogen, helium and other ions.

The solar plasma may be the dominant factor in interplanetary space because it shapes magnetic fields which in turn deflect cosmic rays and the Earth's magnetic field.

Three experiments on Pioneer B will gather data on these ionized particles coming from the Sun, their quantities, energies, and directions.

Plasma Cup Detector -- Massachusetts Institute of Technology

This experiment measures the number, density, direction and energy of positive ions and electrons in the solar wind.

The detector is a Faraday cup with fine tungsten wire grids through which particles must pass to reach a collector plate. Systematic varying voltages on the grids allow the passage of particles in a sequence of 18 energy ranges.

At the energy range being measured, the particles create an electric current which is a measure of the number of particles in each energy range.

Because the spacecraft is spinning, the direction of the incoming particles in the plane of rotation is measured by noting in which direction the probe looks at any instant. The collector is split into upper and lower halves to measure direction of incoming particles in the vertical plane.

This instrument measures electrons with energies from 100 to 1000 electron volts and hydrogen nuclei from 100 to 10,000 electron volts. It can measure particles ranging in density from 400,000 to four billion particles per square centimeter per second.

The experiment weighs 6.1 pounds and requires an average of 2.5 watts of power with peaks of 10.7 watts.

Quadrispherical Plasma Analyzer -- Ames Research Center

This experiment measures particles in the solar wind -- quantities, directions, energies and temperatures.

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It gets its name from the fact that the instrument is made up of two curved plates, one fitting over the other, which represent one-quarter of a sphere. A voltage across the plates is varied to select particles in a sequence and particles being measured at any moment pass between the plates and land on a collector. This produces a current showing the number of particles arriving in each energy range in turn.

Horizontal direction of the particles is measured by noting the direction in which the probe is looking out from the spinning spacecraft at the time of arrival of particles. Vertical direction is measured by eight collector plates which look out in eight directions over an arc of 160 degrees.

The experiment measures electrons with energies from two to 500 electron volts and positive ions with energies from 200 to 10,000 electron volts. It can measure from 50,000 to 100 million particles per square centimeter per second. It weighs 6.3 pounds and uses 1.6 watts of power.

Radio Propagation Detector -- Stanford University and Stanford Research Institute

This experiment measures the total electron content in space between Pioneer and the Earth. On Pioneer VI it found a variation of five to ten electrons per cubic centimeter in interplanetary space.

Possession of this average number for electron density makes possible direct inferences about total average numbers of charged particles, both positive and negative, in the solar atmosphere. It also measures the intrusion of huge tongues of solar gas between the spacecraft and the Earth.

A 150-foot dish antenna at Stanford University in Palo Alto, Cal., will be used to send radio signals at two different frequencies to a special antenna and receiver on the spacecraft.

The speed of radio transmissions is affected by the electrons of the solar plasma and depends on the frequency of the signal. A high frequency signal (423.3 MC) will be sent as a reference and experimenters will then compare the relative phase and delay of receipt of the low frequency signal (49.8 MC) to make total electron content calculations.

The experiment and antenna weigh 6.0 pounds and require 1.6 watts of power.

Cosmic Ray Studies

Cosmic rays are extremely high energy charged nuclear particles moving through space. They are thought to originate from both the Sun and interstellar sources. Most of the particles are hydrogen nuclei but some are nuclei of helium and the heavier elements.

The Pioneer B experiments will attempt to differentiate between cosmic rays coming from the Sun and galactic cosmic rays originating from interstellar space far beyond our solar system.

Solar cosmic rays are present in large numbers in interplanetary space principally during solar storms and seem to originate from small disturbed areas on the Sun.

Galactic cosmic ray particles appear to come from all directions in space. In addition, galactic particles have far higher energies than solar cosmic rays. Occasional galactic particles reach near the speed of light, giving them tremendous energies.

Cosmic Ray Anisotropy Detector -- Graduate Research Center of the Southwest

The objective of this experiment is to measure the characteristics of both solar and galactic cosmic rays.

It is named for the fact that the experiment measures differences in the number of cosmic ray particles arriving from various directions (anisotropy) and determines whether the mass and energy of these particles arriving at the spacecraft vary with incoming direction.

In past experiments, scientists have found variations of about one per cent in the number of galactic rays arriving from various directions. Study of these differences could provide information about the extent of the solar atmosphere and magnetic fields and the nature of the boundary region between the solar and interplanetary magnetic fields.

The experiment consists of a crystal scintillator which produces flashes of light of varying intensity, depending on the energy, direction and type of cosmic ray particle which strikes its crystal lattice.

An anti-coincidence scintillator, two photomultiplier tubes which translate the flashes into electric impulses to radio to Earth, and other electronics will categorize the cosmic ray particles and their directions.

As the spacecraft spins, the instrument detects particles arriving from four different directions in space. It uses the Sun as a reference point in computing the incoming directions of the cosmic rays.

The energy range for hydrogen nuclei is from 3.0 million to 90 million electron volts and for helium nuclei from 130 million to 360 million electron volts.

The instrument weighs 4.4 pounds and requires an average of 1.8 watts of power.

Cosmic Ray Telescope -- University of Chicago

This experiment is designed to measure both solar and galactic cosmic rays.

In measuring galactic cosmic rays, scientists are interested in variations of energy and composition of the particles as the spacecraft moves away from the Earth's orbit. They also want to determine if the distribution of galactic cosmic particles changes with time as the level of the Sun's activity increases during the current solar cycle.

It has been inferred that the Sun's magnetic field indirectly affects the number of low energy galactic cosmic rays arriving at Earth and these measurements are expected to provide information on the nature and extent of the solar magnetic influence within the solar system.

The experiment also will attempt to determine numbers and energies of hydrogen and helium cosmic ray particles arriving from interstellar space and it may provide clues to what interstellar forces have accelerated these particles.

The experiment will use solid state detectors which produce electrical impulses of varying strength depending on energy, direction and type of charged particle passing through their atomic structures.

Equipment includes three solid state detectors, a cesium-iodide scintillator crystal, an anti-coincidence detector and associated electronics. The instrument looks out in a 60-degree cone and in a full circle as the spacecraft spins.

It will measure hydrogen and helium nuclei with energies from one million to 200 million electron volts.

The instrument weighs 4.7 pounds and will require about 1.2 watts of power.

THRUST AUGMENTED IMPROVED DELTA LAUNCH VEHICLE

Delta is a launch rocket program of NASA's Office of Space Science and Applications. Project Management is the responsibility of the Goddard Space Flight Center. Launch agency for Goddard is the Kennedy Space Center's Unmanned Launch Operations. The Douglas Aircraft Co. is the prime contractor.

Delta Statistics

The three-stage Delta for the Pioneer B mission has the following general characteristics:

Height:	92 feet (includes shroud)
Maximum Diameter:	8 feet (without attached solids)
Lift-off Weight:	About 75 tons
Lift-off Thrust:	333,550 (includes strap-on solids)

First Stage (liquid only):

Modified Air Force Thor, produced by Douglas Aircraft Co., engines made by Rocketdyne Division of North American Aviation, Inc.

Diameter:	8 feet
Height:	51 feet
Propellants:	RP-1 kerosene is the fuel and liquid oxygen (LOX) is the oxidizer for the Thor stage
Thrust:	172,000 pounds
Burning Time:	2 minutes, 29 seconds
Weight:	Approximately 67 tons (including solids)

<u>Strap-on solids:</u>

	Three solid propellant rockets produced by Thiokol Chemical Corp.
Diameter:	31 inches
Height:	19.8 feet
Weight:	27,510 (9,170 each) pounds
Burning time:	42 seconds

<u>Second stage:</u>

	Produced by Douglas Aircraft Co., utilizing the Aerojet-General Corp., AJ10-118E propulsion system; major contractors for the auto-pilot include Minneapolis-Honeywell, Inc.; Texas Instruments, Inc.; and Electro-solids, Corp.
Propellants:	Liquid -- unsymmetrical dimethyl hydrazine (UDMH) for the fuel and inhibited red fuming nitric acid (IRFNA) for the oxidizer.
Diameter:	4.7 feet (compared to 2.7 feet for earlier Deltas)
Height:	16 feet
Weight:	6½ tons (compared to 2½ tons for earlier Deltas)
Thrust:	About 7,800 pounds
Burning Time:	6 min. 14 sec. (compared to 150 seconds for earlier Deltas)
Guidance:	Western Electric Co.

<u>Third stage:</u>

	United Technology Center FW-4D motor
Propellants:	Solid
Height:	58 inches
Diameter:	20 inches
Weight:	660 pounds

Thrust: 5,595 pounds

Burning time: 31 seconds

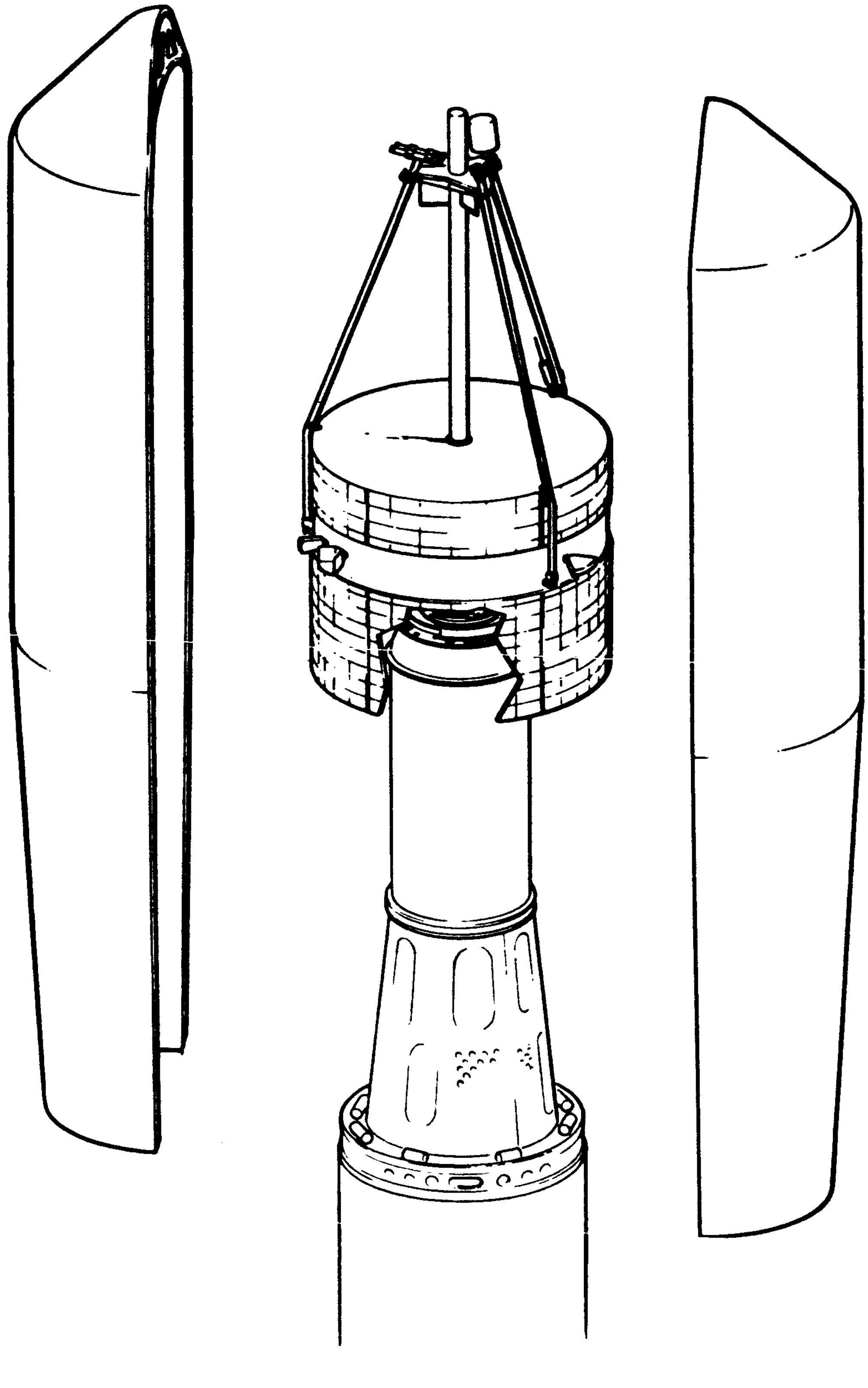
PIONEER B LAUNCH WINDOW

To inject Pioneer B into the desired orbit, Delta can be launched only at certain times of the day. All times are Eastern Standard Time.

Date	Opens	Closes
Aug. 17	10:18 am	10:24
Aug. 18	10:14	10:20
Aug. 19	10:12	10:21
Aug. 20	10:12	10:22
Aug. 21	10:12	10:20

Additional opportunities have been computered out to Aug. 28.

PIONEER B - MOUNTED ON DELTA THIRD STAGE



DELTA FLIGHT PLAN

Delta No. 40 will be launched from Complex 17, Pad A, on a launch azimuth of 108 degrees. If orbit is achieved, it will be the 37th satellite hurled into orbit out of 40 Delta attempts.

The Delta No. 40 flight will be the fifth launching of the more powerful Thrust Augmented Improved Delta, which can orbit three times more weight than the earlier Deltas, and the third Delta flight for the uprated FW-4D third stage solid rocket.

Pioneer B's nominal aphelion (most distant point from the Sun) is 1.1 astronomical units (AU) (102 million miles) and the perihelion (closest to Sun) is 1.01 A.U. (92 million miles). To achieve this orbit, Delta will perform a "dog leg," or turning maneuver, during the 16-minute coast period between 2nd stage burnout and 3rd stage ignition. The 30-degree yaw-right maneuver will be commanded by the second stage auto-pilot.

At injection, the spacecraft will be traveling more than 24,000 miles per hour. This speed will place Pioneer B into a larger orbit around the Sun than the Earth's orbit. The Earth will pass the spacecraft 38 days after launch and the satellite will steadily fall behind the Earth in its course around the Sun.

After Pioneer is injected into solar orbit, it will travel below the South Pole and into space ahead of the Earth, on a course slightly under and almost parallel to the Earth's orbital plane.

Two seconds after third stage separation (about 25 minutes after launch), the spacecraft booms will deploy automatically. At the same time, automatic changes in spacecraft attitude will begin to orient the spacecraft covered with solar cells perpendicular to the Sun.

Sun orientation is critical to survival of the spacecraft. Without power from its solar cells, spacecraft batteries would fail within an hour. The Sun orientation maneuver is expected to take about five minutes.

The high power amplifier for the spacecraft transmitter turns on immediately after third-stage separation, sending out a wide beam signal via the spacecraft's low-gain antenna.

About 35 minutes after lift-off, first acquisition by the Deep Space Network tracking station at Johannesburg, South Africa, occurs. Condition of the spacecraft is checked via incoming telemetry and all spacecraft systems are checked out. A key task is to check solar cell operation and electric power output. Within the first three hours after launch, this checkout process is expected to be complete.

During the first four hours, the six scientific experiments are planned to be turned on, one at a time.

At about 14 hours after launch, the first scientific data from the Radio Propagation Detector is expected to be sent from Goldstone to Stanford University at Palo Alto, Cal.

Experimenters there will begin a process which will continue throughout the mission. They will send radio signals from Stanford's 150-foot dish antenna directly to the Stanford radio receiver aboard the spacecraft.

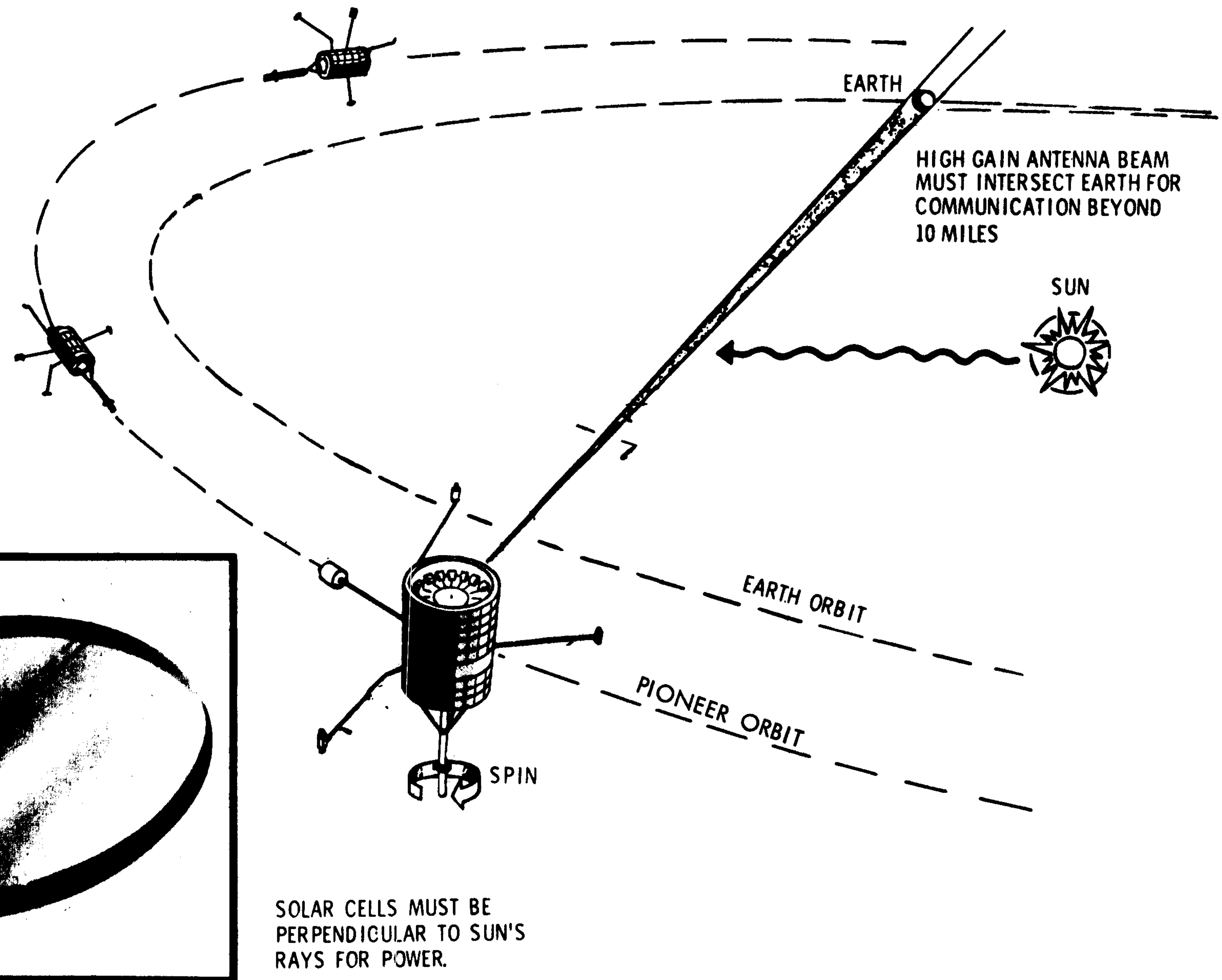
The spacecraft will return data on the Stanford signal to Goldstone, which will forward it to Stanford. Then begins a continuous process in which each Stanford communication to its spacecraft receiver is based on the latest data returned from its scientific experiment aboard Pioneer.

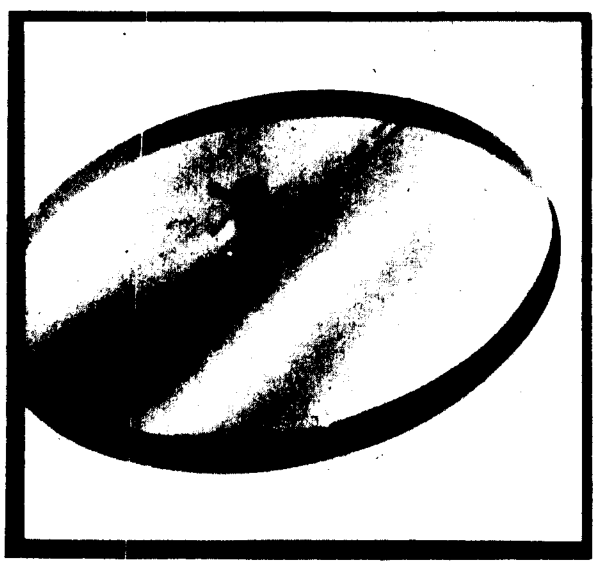
A day and a half after launch on the second pass over Goldstone, the crucial Earth acquisition maneuver will be made. Controllers will command the spacecraft to change its position gradually over a period of several hours until its high-gain antenna points precisely at the Earth to maintain a strong, two-way radio signal for the life of the mission.

After this, if the spacecraft should drift from either Sun or Earth orientation, commands can be sent to reacquire.

At 38.5 days after launch, the Earth will catch up with the spacecraft passing between it and the Sun. Pioneer B will then be 3,520,000 miles from the Earth in the region of a possible Earth's magnetic tail, and scientific data will be scanned for effects of a tail.

PIONEER EARTH/SUN ACQUISITION
(COMPLETED TWO DAYS AFTER LAUNCH)





HIGH GAIN BEAM RADIATES 360° FROM ANTENNA. BEAM IS 5° WIDE.

After the first few weeks, the DSN is planned to track the spacecraft for one pass a day of about 10 hours from Goldstone or Canberra.

For this partial tracking, Pioneer B uses its memory system to store selected portions of 19 hours of data. When contact with the spacecraft is resumed each day, it is first commanded to send these stored data, before reporting in real time.

About 69 days after launch, to get a clearer signal, Pioneer will shift its rate of transmitting information down from the original 512 bits per second (bps) to 256 bps. As the spacecraft continues to move farther from Earth, its data rate will be steadily reduced: at 89 days to 64 bps, and at 123 days to 16 bps.

After the first few months, Pioneer B will travel away from the Earth more slowly than did Pioneer VI, and can maintain the 16 bps data rate until to six months. If the spacecraft continues to function well, the mission will continue.

After six months, if still operating, Pioneer B will shift to 8 bps and retain that data rate until it is 60 million miles from Earth at eight months.

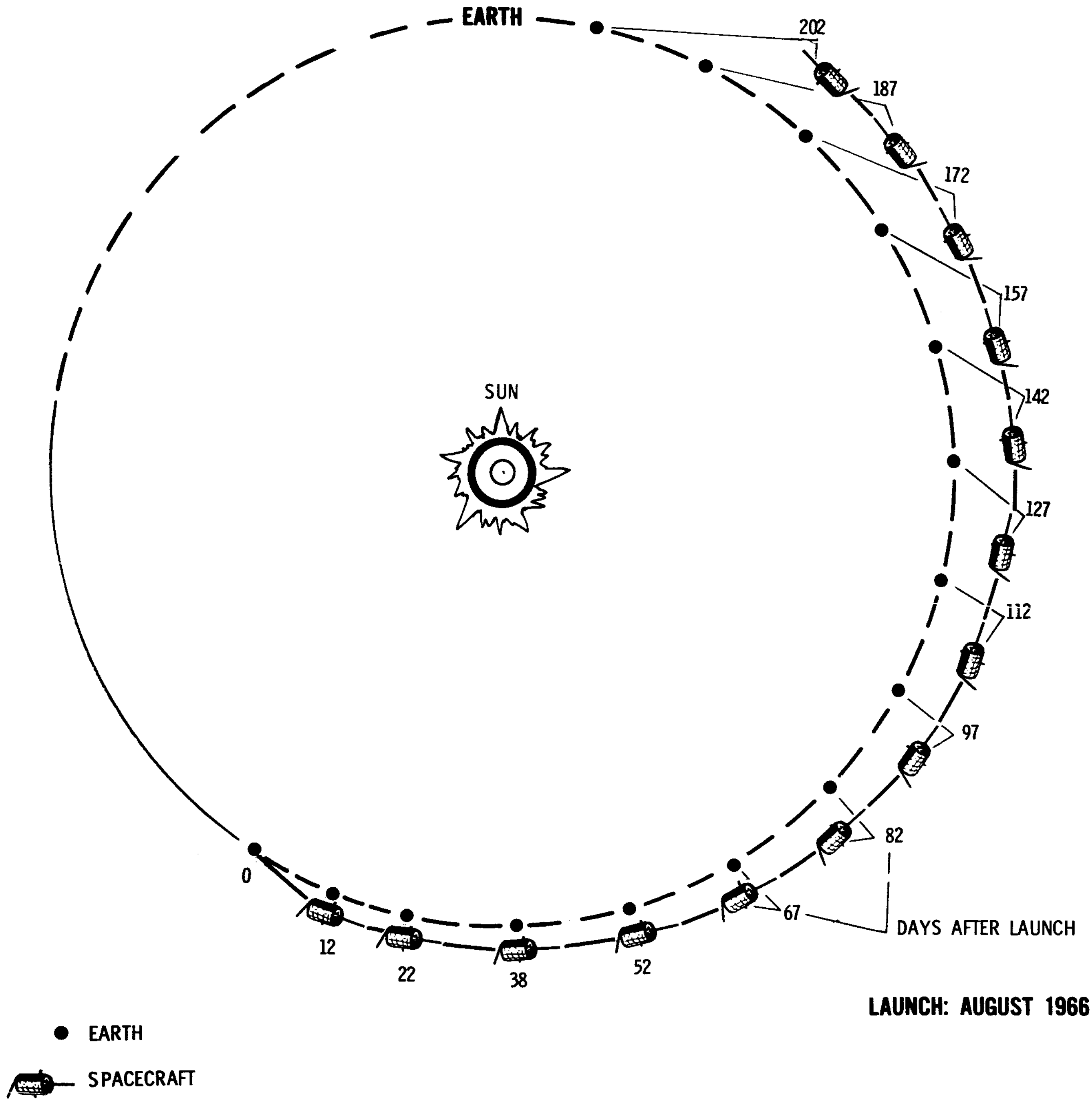
At eight months, tracking of Pioneer B will shift to the 210-foot antenna at Goldstone, which will also be tracking Pioneer VI until June 1967.

With the greater sensitivity of the 210-foot antenna, the data rate of Pioneer B can be raised to 64 bits per second, and the spacecraft can return data out to around 130 million miles, a point it will reach about mid-1968.

THRUST AUGMENTED IMPROVED DELTA FLIGHT EVENTS (NOMINAL) FOR THE PIONEER B MISSION

EVENT	TIME	ALTITUDE (STATUTE MILES)	SURFACE RANGE (STATUTE MILES)	APPROXIMATE VELOCITY MILES PER HOUR
Strap-on Solids Burnout	42 sec.	7 miles	3 miles	1,900
Strap-on Solids Separation	1 min. 10 sec.	15 miles	12 miles	2,700
Thor burnout	2 min. 29 sec.	58 miles	104 miles	9.600
2nd stage ignition	2 min. 35 sec.	62 miles	116 miles	9,600
Shroud separation	2 min. 55 sec.	77 miles	163 miles	9,800
2nd stage burnout	8 min. 49 sec.	173 miles	1,266 miles	17,700
3rd stage ignition	24 min. 50 sec.	250 miles	5,524 miles	17,400
3rd stage burnout	25 min. 21 sec.	257 miles	5,754 miles	24,400

HELIOCENTRIC ORBIT FOR PIONEER B



THE DEEP SPACE NETWORK

Three 85-foot antennas of the Deep Space Network (DSN) will track Pioneer B for eight months as far as 60 million miles from the Earth.

The DSN's new long-range 210-foot antenna will receive data from both Pioneer B and Pioneer VI out to some 130 million miles. Pioneer VI will reach this limit by June 1967, Pioneer B by mid-1968.

The Deep Space Network (DSN) consists of seven permanent space communications stations, a launch monitoring and spacecraft checkout station at Cape Kennedy, the Space Flight Operation Facility (SFOF) in Pasadena Calif., and a ground communications system linking all locations.

The DSN is under technical direction of the Jet Propulsion Laboratory for NASA.

During launch, Delta will be tracked by Eastern Test Range stations at Cape Kennedy, Antigua, Grand Turk, Grand Bahama Islands, Ascension, Pretoria and a tracking ship in the South Atlantic.

Tracking data obtained during launch will be computed both at Cape Kennedy and at the SFOF so that accurate predictions of Pioneer's position can be sent to the DSN stations.

The permanent DSN stations provide 360-degree coverage around the Earth, so that one or more of their 85-foot dish antennas can always "see" the spacecraft.

Three permanent DSN stations will be used for Pioneer B, the Echo station at Goldstone, Calif., the Tidbinbilla station near Canberra, Australia, and the station at Johannesburg, South Africa which will track during the first four days of the mission. All have 85-foot diameter receiving antennas and 10,000-watt transmitters.

The new Mars station at Goldstone, which has a 210-foot diameter antenna will track Pioneer B beyond 60 million miles from Earth.

For Pioneer tasks, the DSN stations have been equipped with special command encoders for communication with the spacecraft. Other station equipment includes demodulators and synchronizers to translate spacecraft telemetry and Pioneer computer programs for station computers.

The DSN tracks the spacecraft by means of two-way Doppler. A signal is sent from the antennas at a precisely known frequency, and a transponder aboard the spacecraft returns it at a frequency increased by an exact ratio. Motion of the spacecraft away from the Earth causes both frequencies as they are received, to shift slightly downward. The total frequency shift both going and coming is used to calculate the average one-way shift.

Since the frequency of the signal sent out is precisely known, this average Doppler shift can be used to calculate velocity within a few feet per second, despite distances of millions of miles. From these velocity measurements exact spacecraft orbit and distance from Earth can then be derived.

Scientific and engineering measurements radioed from the spacecraft will be received and recorded on tape at the tracking stations. A computer checks the data and "strips off" 15 to 20 percent quick-look engineering information. Quick-look information is then transmitted to the Space Flight Operations Facility via teletype from overseas, and by microwave radio from Goldstone to be used for daily operations.

Within a few weeks after launch, command will shift to the Pioneer Control Facility at the Ames Center.

The complete tape of data received from the spacecraft is mailed to the SFOF for checking and duplication and then sent to Ames. There it is processed into separate tapes at the Pioneer Data Reduction Center, and is distributed to experimenters, contractors, and project personnel.

The nerve center of the Network is the Space Flight Operations Facility at Pasadena. The DSN stations are linked to the SFOF by a ground communications network, operated by the Goddard Center overseas and by the DSN in the U. S.

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The SFOF will be manned by some 50 persons during the Pioneer mission, divided evenly among Ames, DSN, and TRW Systems personnel.

Mission control personnel are supported by three technical teams. The DSN Flight Path Analysis Group will evaluate tracking data and determine flight path of the spacecraft.

The Pioneer Project Space Science Analysis Group will evaluate data from experiments, and generate commands controlling the experiments.

The Pioneer Spacecraft Performance Analysis Group evaluates the condition of the spacecraft from quick-look engineering data radioed to Earth and generates commands to the spacecraft affecting its performance.

PIONEER PROJECT OFFICIALS, EXPERIMENTERS, AND MAJOR CONTRACTORS

NASA Headquarters

Dr. Homer E. Newell, Associate Administrator for Space Science and Applications.

Jesse E. Mitchell, Director, Physics and Astronomy Programs.

M. J. Aucremanne, Manager, Interplanetary and Solar Probes.

Andrew Edwards, Jr., Associate Program Manager, Pioneer.

Dr. Edward A. Gaugler, Pioneer Program Scientist.

Theodrick B. Norris, Delta Program Manager.

Ames Research Center

Dr. H. Julian Allen, Director.

Robert M. Crane, Assistant Director for Development.

Charles F. Hall, Pioneer Project Manager.

Dr. John H. Wolfe, Pioneer Project Scientist.

Ralph W. Holtzclaw, Pioneer Spacecraft Systems Manager.

Joseph E. Lepetich, Pioneer Experiments Systems Manager.

Kennedy Space Center

Robert H. Gray, Assistant Director for Unmanned Launch Operations.

Hugh A. Weston, Jr., Chief, Delta Operations.

Goddard Space Flight Center

William B. Schindler, Delta Project Manager.

Jet Propulsion Laboratory

John W. Thatcher, Pioneer Tracking and Data Acquisition Systems Manager.

TRW Systems Group

Dr. Aubrey G. Mickelwait, Pioneer Project Manager.

Experimenters

Single Axis Magnetometer:

Principal Investigator: Dr. Norman F. Ness, Goddard Space Flight Center.

Plasma Cup Detector:

Principal Investigator: Dr. Herbert S. Bridge, Massachusetts Institute of Technology
Co-Investigator: Dr. Alan J. Lazarus and Dr. Frank Scherb, MIT

Quadrispherical Plasma Analyzer:

Principal Investigator: Dr. John H. Wolfe, Ames Research Center
Co-Investigator: Richard W. Silva, Ames

Radio Propagation Detector:

Principal Investigator: Dr. Von R. Eshleman, Stanford University
Co-Investigator: Dr. Allen M. Peterson and Dr. Owen Garriott, Stanford University; Dr. Ray L. Leadabrand, Standord Research Institute

Cosmic Ray Anisotropy Detector:

Principal Investigator: Dr. Kenneth G. McCracken, Graduate Research Center of the Southwest
Co-Investigators: Dr. U. Ramachandra Rao and William C. Bartley, GRCSW

Cosmic Ray Telescope:

Principal Investigator: Dr. John A. Simpson, Fermi Institute, University of Chicago
Co-Investigators: Dr. Chang-Yun Fan and James E. Lamport, Fermi Institute, University of Chicago

SPACECRAFT CONTRACTORS

TRW Systems Group, Redondo Beach, Cal., is prime contractor for the Pioneer spacecraft. Others include:

Eagle Picher Joplin, Mo.	Batteries
Radio Corporation of America Mountain Top, Pa.	Solar Cells
Optical Coating Labs., Inc. Santa Rosa, Cal.	Solar Cell Cover Glasses
Rantec Calabasas, Cal.	Diplexer and Bandpass Filter
Hughes Aircraft Co. Los Angeles	Traveling Wave Tubes
Electronic Memories, Inc. Hawthorne, Cal.	Data Storage Unit
Vitro Electronics Silver Spring, Md.	Telemetry Receiver
Solid State Products, Inc. Salem, Mass.	Photo Silicon Control Rectifiers
Western Semiconductors Santa Ana, Cal.	Photo Silicon Control Rectifiers
Sterer Engineering and Manufacturing Los Angeles	Pressure Regulator and Relief Valve
Weston Hydraulics Van Nuys, Cal.	Pneumatic Solenoid Valve
Quantitron Los Angeles	Coaxial Switch

Delta Launch Rocket

Douglas Aircraft Co., Santa Monica, Cal.

In addition to the firms listed, more than 100 other firms are contributing to the Pioneer spacecraft and its supporting systems.

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